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REPORT TO THE CONGRESS



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Need To Strengthen Management Control Over The Basic Research Program Administered By The Air Force Office Of Scientific Research B-170801

Department of the Air Force

BY THE COMPTROLLER GENERAL
OF THE UNITED STATES

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JAN. 29, 1971



COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-170801

To the President of the Senate and the
Speaker of the House of Representatives

This is our report on the need to strengthen management control over the basic research program administered by the Air Force Office of Scientific Research. 1276

Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Director, Office of Management and Budget; the Secretary of Defense; and the Secretary of the Air Force. 17

Thomas P. Staats

Comptroller General
of the United States

D I G E S T

WHY THE REVIEW WAS MADE

The General Accounting Office (GAO) sought to evaluate the practices followed by the Air Force Office of Scientific Research in selecting, managing, and using the results of research projects, most of which were proposed and performed by university researchers. The Office of Scientific Research supports about 1,200 projects costing about \$285 million.

FINDINGS AND CONCLUSIONS

Relevance of research projects

Federal policy is that the National Science Foundation will provide Federal support for general-purpose basic research. Other Federal agencies should support basic research only in areas closely related to their missions. This policy is set forth in an Executive order as well as a Department of Defense (DOD) directive. (See p. 7.)

Guidelines for applying this policy were not provided, however. The Office of Scientific Research interpreted the policy broadly when selecting projects to be funded. Also, it did not prepare written justifications showing the basis for supporting the projects. (See p. 10.) Although many of the projects appeared to be closely related to the Air Force mission, some--including the following examples--did not.

Methodology for Analysis of Internal
Social Movements (\$201,860)

The purpose of this research was to construct and test a workable theory of the relationship between the rise of ideological movements and the changes in socioeconomic systems of selected countries in two different cultures, the western and the oriental. (See p. 11.)

Automatic English Sentence
Analysis (\$261,000)

The volume and redundancy of natural language records, as well as the existence of a number of different languages in which significant

information is recorded, create the need for a capability for automatic processing of this material for such purposes as producing compressed records, extracts of them, indexes to them, and translation from one to another. Research results should furnish an understanding of how computers may be used for natural language analysis for such applications as text compression, extracting, indexing, and translation. (See p. 15.)

Support of research not closely related to the Air Force mission reduces the effectiveness of its basic research program since fewer dollars are available for closely related research.

Immediately after GAO's evaluation the Air Force reviewed all current projects in the Office of Scientific Research as part of a DOD-wide study following enactment of the 1970 Defense Procurement Authorization Act. This act contained a provision forbidding the use of 1970 funds for research projects which did not have a direct and apparent relationship to a specific military function or operation. (See p. 22.) The Deputy Secretary of Defense stated that this provision represented no change in DOD's longstanding relevancy policy. Nevertheless, the Air Force disqualified 115 Office of Scientific Research projects--10 percent of the active projects--because of insufficient relevance. Included were

- 26 nuclear physics projects (\$12 million) which related to functions of the Atomic Energy Commission and the National Aeronautics and Space Administration and

- a project to develop a better rabies vaccine (\$56,800). The Air Force review panel concluded that rabies was not a unique military problem and that research in this area should be conducted by the Communicable Disease Center of the National Institutes of Health. The Center has been engaged in rabies research for over 30 years and has awarded grants totaling \$2.3 million over the past 12 years. (See p. 23.)

Management procedures

The Office of Scientific Research was not obtaining maximum benefit from its basic research program because certain procedures had not been established and existing procedures were not consistently followed.

- Surveillance over ongoing research projects was not adequate. In some cases researchers deviated significantly from negotiated budgets or the agreed amount of the principal investigator's time to be devoted to the project, but the Office of Scientific Research did not recognize the deviation until too late to correct the problem. For example, one principal investigator agreed to devote half his time to the 3-year project but instead spent only 2 months at the outset. (See p. 30.)

--Procedures for ensuring that all scientific reports had been received were not consistently followed. Scientific reports on some research efforts were not obtained at all, and others were obtained only after long delays. (See p. 36.)

--Procedures for disseminating research results were not fully effective. Of the scientific reports received, some were not distributed to Air Force users or made available to the Defense Documentation Center. The Center is responsible for making research results available to any qualified Government user. (See p. 40.)

RECOMMENDATIONS OR SUGGESTIONS

> GAO suggested that DOD issue guidelines adequately limiting defense funding to projects which were clearly relevant to assigned missions. Consideration should be given to the most appropriate agency to support the research in view of the missions and research performed by other organizations--military and civilian, Government and private. Instructions should be issued requiring the need for each contract to be clearly established in writing. (See p. 26.)

GAO also made a number of suggestions for improving management procedures. (See pp. 34, 39, and 44.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

DOD said that relevance had always been an established criterion of their research activities and noted that, even prior to enactment of the 1970 act, actions were taken to deemphasize certain areas of research and, in some cases, to transfer projects to other Government agencies. (See p. 26.)

Subsequent to GAO's fieldwork and passage of the 1970 act, the Air Force issued regulations requiring:

--Each research effort selected for funding to have a direct and coherent relationship to an Air Force function or operation.

--Evaluation as to whether each project is more appropriate for the Air Force than for some other agency.

--A written record of that evaluation. (See p. 26.)

Also, the Office of Scientific Research took corrective actions for improving management control over research work. (See pp. 35, 39, and 44.)

These actions, if properly implemented, should improve management of the basic research program.

Other DOD research

- × The other military services and defense agencies conduct similar research programs. GAO recommends that DOD review existing regulations of these organizations, to determine if improvements are needed like those made by the Air Force. (See p. 27.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

This report is being submitted to the Congress because of congressional concern over the relevance of DOD research to its mission and continuing congressional interest in DOD's management of research and development activities.

C o n t e n t s

	<u>Page</u>
DIGEST	1
CHAPTER	
1 INTRODUCTION	5
2 NEED FOR DEFINITIVE GUIDELINES FOR SELECTING RESEARCH PROJECTS	7
Governmental policy limits type of re- search Air Force can sponsor	7
Close relevance of little concern in ear- lier years	8
Relevance to Air Force mission inter- preted broadly	10
Air Force review of OSR projects	22
Internal audit	25
Conclusion	25
Agency action and our evaluation	25
Recommendation	27
3 NEED FOR BETTER SURVEILLANCE OVER RESEARCH PROJECTS	28
OSR requirements provide for monitoring	28
Monitoring not done consistently and uni- formly	29
Examples of administrative problems	29
Conclusions	34
Agency actions and our evaluation	34
4 RESEARCH RESULTS NOT OBTAINED OR NOT OB- TAINED PROMPTLY	36
Scientific reports must be submitted to OSR promptly	36
Reports not received or delayed unduly	36
Conclusion	38
Agency actions and our evaluation	39
5 NEED FOR MORE EFFECTIVE DISSEMINATION OF RE- SEARCH RESULTS	40
Informal dissemination of research re- sults	40

	<u>Page</u>
CHAPTER	
Conclusion	44
Agency actions and our evaluation	44
6 SCOPE OF REVIEW	46
APPENDIX	
I Listing of 46 projects reviewed	49
II Letter dated June 15, 1970, from the Director of Defense Research and Engineering to the General Accounting Office	56
III Principal officials of the Department of Defense and the Department of the Air Force responsible for administration of activities discussed in this report	75

ABBREVIATIONS

DOD	Department of Defense
GAO	General Accounting Office
OSR	Air Force Office of Scientific Research

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CHAPTER 1

INTRODUCTION

The General Accounting Office has made a review of selected management aspects of the basic research program administered by the Air Force Office of Scientific Research (OSR), a component of the Office of Aerospace Research, Department of the Air Force.¹ Our inquiries were directed primarily toward evaluating the effectiveness of management policies and practices followed by OSR, relating to the selection and monitoring of research projects and evaluation and dissemination of project results. Of approximately 1,200 research efforts, we selected for review 46 on which, over the years, OSR had expended or committed about \$21 million.

The purpose of the Office of Aerospace Research is to manage the conduct and support of basic research essential to the continued superiority of the Air Force operational capability and the conduct and support of exploratory development efforts. The mission of OSR is to support programs of extramural (out-of-house) basic research in domestic and foreign universities, nonprofit institutions, and industry through contracts and grants. Other Office of Aerospace Research components conduct programs of basic and exploratory development research in-house and programs through contracts that closely support and extend in-house efforts.

OSR is headed by an executive director and is organized into six scientific directorates and one procurement directorate. The scientific directorates are responsible for evaluating and selecting research proposals, monitoring research projects, and evaluating and disseminating project results. The procurement directorate is responsible for the negotiation and administration of research contracts and grants.

¹Effective July 1, 1970, the Office of Aerospace Research was merged into the Air Force Systems Command; however, the mission and operations of its subordinate, OSR, which are dealt with in this report, remain essentially unchanged.

OSR supports research in chemistry, mathematical sciences, electronics, mechanics, energy conversion, general physics, nuclear physics, astronomy and astrophysics, behavioral and social sciences, and biological and medical sciences.

During the time of our review, OSR was supporting about 1,200 research grants and contracts with 391 research institutions. A total of about \$285 million had been expended on or approved for these 1,200 projects at the time of our review. About 75 percent of the research grants and contracts had been renewed one or more times, and about one third of the renewed projects had been supported continuously for 6 years or longer.

The very nature of contracted research--the indefiniteness of the required work and the high degree of uncertainty about the outcome of the work--involves unique problems for Government scientists and contracting officers and makes it a difficult area to manage. Despite the difficulties, a measure of control is essential to protect the interests of the Government and to ensure that maximum benefits are derived from the millions of dollars spent annually on such research. In subsequent chapters of this report, we described the problems that came to our attention during this review as well as our pertinent conclusions and recommendations.

The scope of our review is described on page 46. The principal officials of the Department of Defense and the Department of the Air Force responsible for the administration of activities discussed in this report are listed in appendix III.

CHAPTER 2

NEED FOR DEFINITIVE GUIDELINES

FOR SELECTING RESEARCH PROJECTS

OSR has been subject to the broad policy statements which are set forth in Executive Order 10521 and DOD Directive 3210.1, which limit defense agencies to the support of research which is closely related to military needs. Definitive guidelines for use in selecting research projects were not provided, however, and OSR interpreted relevance to the Air Force mission very broadly in selecting projects which it funded.

In its review of 46 of OSR's active research projects, GAO noted that the relevancy of the projects was generally not adequately documented and that a number of projects did not appear to be closely related to military needs. An Air Force review of OSR's active research projects, subsequent to the completion of our review and in response to the direction of the Deputy Secretary of Defense, resulted in the disqualification of 115 projects because of insufficient relevance.

GOVERNMENT POLICY LIMITS TYPE OF RESEARCH AIR FORCE CAN SPONSOR

Since 1954 there have been restrictions on the type of research which the Air Force and other military services can sponsor. In that year Executive Order 10521 was issued. Section 4 of that order states that the National Science Foundation shall be increasingly responsible for providing support by the Federal Government for general purpose basic research. This section of the order goes on to state that other Federal agencies should continue to support basic research in areas which are closely related to their missions. DOD Directive 3210.1, which was issued to implement the Executive order, states that it is the policy of DOD to conduct and support a broad basic research program to provide fundamental knowledge with emphasis on that related to the needs of DOD.

In 1968 the Congress indicated that DOD should be more selective in determining the research efforts which it sponsored. In House Report 1735, dated July 18, 1968, the House Committee on Appropriations, in commenting on the DOD appropriation bill for fiscal year 1969, stated:

"There is considerable evidence that the Department has found sufficient research and development funds available in past years to contract for volumes of studies on a myriad of topics, some of which have little or no apparent application to weapons systems developments or even to military matters. Some studies continue for months and years without reaching conclusions. Not enough attention has been given to evaluating the need for such study efforts and the elimination of all studies not absolutely essential.

"Among the vast numbers of individual projects funded in R.D.T.&E. (Research, Development, Test, and Evaluation), there are many desirable programs which are not absolutely essential at this time. Such programs can be delayed or postponed without adverse effect to the Nation's defense."

CLOSE RELEVANCE OF LITTLE CONCERN IN EARLIER YEARS

We found that, originally, OSR did not view itself as being restricted to sponsoring research projects that were closely related to Air Force programs.

Subsequent to the issuance of Executive Order 10521 in March 1954, the Chief of the Office of Scientific Research held the following views:

"*** Executive Order 10521 *** restricted agencies other than NSF [National Science Foundation] to 'basic research in areas which are closely related to their missions.' *** To OSR, particularly to [the Chief], this restriction meant one thing: the organization would henceforth be required to defend its program, and its budget, on the basis of

relevance to existing Air Force requirements, the difficulty inherent in intelligently relating basic research with existing requirements notwithstanding. Equally clear to [him] was that OSR's program, if it was to continue to be of maximum usefulness to the Air Force, would have to go on as before. The problem, as [he] stated it later, was that 'by virtue of the Executive Order [basic research] could no longer be labeled basic research' if the Air Force were to retain a measure of control over it. In the end, OSR solved the problem by a skillful exercise in semantics. *** And, as will be shown, executive order or no, in the face of increasing opposition to basic research by the Bureau of the Budget, OSR would have had to resort to some such tactic sooner or later." (Underscoring supplied.)

Thus, according to its history,¹ OSR originally resisted Executive Order 10521 and continued to support basic research that was not closely related to Air Force problems.

¹A History of the Air Force Office of Scientific Research, Vol. I, Komons, Office of Aerospace Research.

RELEVANCE TO AIR FORCE MISSION
INTERPRETED BROADLY

As a part of our review, we examined into the statements which OSR scientists had made to show the relevancy to the Air Force mission of the projects which were selected for support.

We believe that to be relevant a project should have a traceable, significant, logical connection to the Air Force mission, which has been stated as the organizing, training, and equipping of forces for the defense of the United States against air attack; the achievement of general air superiority; and the prosecution of air combat operations against the enemy in time of war.

OSR instructions for evaluation of research proposals were contained in OSR Headquarters Operating Instruction 80-4, dated February 10, 1965. This instruction suggested, but did not require, that a determination be made of the relevance of proposed projects to the Air Force mission, as shown by the section quoted below.

"The project scientist will, upon completion of the evaluation of the proposal, set forth *** a concise, descriptive statement of his evaluation and recommendation based, where appropriate, on comments of reviewers. To be included in this section will be pertinent comments on such factors as *** Air Force and DOD relevance, etc. The foregoing factors should not be considered as mandatory or limiting." (Underscoring supplied.)

Although the OSR instruction placed upon the project scientist a requirement for an evaluation of the relevancy of the project to the Air Force mission, the portion of the instruction which we have underlined tended to make the requirement permissive and we found that it was more often ignored than observed.

In response to our request for written statements of project relevance, we were furnished with copies of project summaries which had been prepared for annual review

purposes. A listing of the 46 projects, which includes the statements of relevance, is presented in appendix I.

The breadth of OSR's determinations of relevancy is apparent from some of the statements made to indicate relevance. The statements seemed to closely relate some projects to the Air Force mission. Some projects, however, seemed much farther removed from its mission. The remoteness of some projects from areas of direct Air Force concern is illustrated by the justifications for the following five projects.¹

Methodology for Analysis of Internal Social Movements (\$201,861)

The OSR-prepared abstract on this project described it as follows:

"The purpose of this research is to construct and test a workable theory of the relationship between the rise of ideological movements and changes in socio-economic systems of selected countries in two different cultures, one western and the other oriental. The program has two partially overlapping phases: a. Formulation of a set of propositions or hypotheses which identify critical variables in social system change, and which have important effects on the nature and direction of ideological movements and b. the testing of hypotheses on the basis of inventory of social movements in these two widely divergent social systems, China and Germany, through case studies. Secondary data from domestic and foreign libraries and information centers will be made available in a computer based data file and combined with the results of case studies a comparative analysis of the two social systems. With the techniques being developed and tested it will be possible to take

¹ Subsequent to the GAO review, the Air Force reviewed all current OSR projects. The second and third described projects expired prior to the Air Force review, and the other three were found by the Air Force to have insufficient relevance. (See p. 22.)

advantage of computers to analyze more complete data than could otherwise be manageable. Results will be useful for environmental and political analysis and forecasting by Air Force systems planners." (Underlining supplied.)

It is pertinent to note that the abstract did not establish that the research was related to the Air Force mission or to specific Air Force functions. Also, it did not show that the research had been requested by any particular user of such information. Rather, it stated that the results would be useful to "Air Force systems planners."

Criteria for the Design of New
Forms of Organization (\$176,774)

The OSR-prepared abstract on this project described it as follows:

"The overall objective of this study is to develop criteria from research for the design of new forms of organization or the planned change of existing organizations, in order to effectively accomplish different organizational goals. Phase I specifies preliminary design criteria on the basis of an analysis of prior experiences in organizational design. Phase II is testing the effectiveness of these design criteria by applying them to ongoing organizational design activities and to modify the criteria, as appropriate. Phase III will synthesize and publish the results of this investigation in a Handbook of Organizational Design, appropriate for the use of managers in innovative forms of organization in government and private institutions. This handbook will be especially useful to Air Force and other military supervisory staffs engaging in the planning of organizational change and adaptation to new conditions." (Underlining supplied.)

It is again pertinent to note that the Air Force did not state what organizational problems it had which needed resolving through this research. The research seemed to

have been oriented very broadly to apply to any form of organization within or outside the Government, as shown by the statement that the results would be published in a handbook appropriate for use in Government and private institutions. Further, the results were obtained by observing reorganizations in Government, industrial, and educational institutions, to analyze the usefulness of different principles and tools for organizational design. This information was to be used to develop criteria for the design of research organizations, educational organizations, and operational or production organizations.

Socio-Cultural Aspects
of Development (\$82,920)

The OSR-prepared abstract on this project described it as follows:

"This investigator will make a comparative analysis of six developing countries on three continents, with regard to the influence on attitudes, values, and behavior of a wide variety of social factors and institutions. Data have already been collected through interviews in each of these countries of a sample of 1,000 subjects, including workers, peasants, and students. The contribution of each of the following to making people hold more modern attitudes will be assessed: Education, social origins, urban experience, exposure to mass-communication, and factory work. The completed interviews touched on almost every major aspect of value judgments and attitudes toward family size, participation in voluntary organizations, etc. The analysis will show the relative contribution which each type of background experience makes toward modernization of attitudes, both when it is acting alone, and in combination with other influences.

"This research will make a comparative analysis of data already collected, from six countries on three continents, on the important social and institutional factors which influence people in developing countries to have more modern attitudes

and act on them. These comparisons may indicate where a country is ahead or lagging behind in its development. This knowledge will be very useful in guiding programs for military aid and policy planning. (Underlining supplied.)

OSR subsequently acknowledged the remoteness of this project from the Air Force mission when the following statement was made to the contractor in explaining the discontinuance of further Air Force support.

"For each task submitted for review we must demonstrate relevance to the Air Force mission, proposed Air Force use of the results and, also, issue a guarantee that the study will not invite attack from Congress, the press or the general public. We did not undertake to support your work with these objectives in mind, and I doubt that [we] would claim that what you are doing is directly and uniquely applicable to the Air Force."

Preparation of a Manuscript for a Reference Book on Laboratory Animal Diseases (\$82,120)

The OSR-prepared abstract on this project described it as follows:

"Comprehensive information of laboratory animal diseases is not readily available to those who need it. A lot of information exists but little has been published - that which has been published is scattered throughout the literature, frequently in obscure journals. The purpose of this project is to get experts in the various facets of laboratory animal diseases to review the literature in their area and to add to it any unpublished information either in their possession or of which they are aware. All of this information will then be compiled into a reference book organized by etiologic agent. This book will aid in the diagnosis, prevention and treatment of spontaneous illnesses of research animals. It will also be useful in

evaluating experimental results by helping to differentiate between spontaneous and experimentally induced lesions. Its long-term value will be to point up areas where more research is needed. The results will be relevant to the extensive use of animals in Air Force research." (Underlining supplied.)

It should be noted that the abstract did not establish that the research was relevant to the Air Force mission or on what basis it was concluded that support of this general-purpose type of project was appropriate for the Air Force.

Automatic English Sentence
Analysis (\$261,001)

The OSR-prepared abstract on this project described it as follows:

"The volume and redundancy of natural language records, as well as the existence of a number of different languages in which significant information is recorded, create the need for a capability for automatic processing of this material for such purposes as producing compressed record, extracts of them, indexes to them, and translation from one language to another. This effort is studying the structures of several natural languages, the way words are used to express meaning, and the relationships that exist between words and within strings of words for the purpose of establishing rules comprehensible to machines for the automatic manipulation of natural language text. In prior research, a machine-verified procedure was developed for analyzing natural language sentences and theories pertaining to syntax and semantics were formulated and tested. Proposed research will extend the procedure to incorporate dictionary look-up and idiomatic phrases. The data base will be enlarged and the procedure applied to coherent sequences of sentences. Attempts will be made to specify a grammar of interpropositional relations that can be used for automatic selection of sentence

interpretations in the analysis of text. Research results should furnish an understanding of how computers may be used for natural language analysis for such applications as text compression, extracting, indexing, and translation." (Underlining supplied.)

Here, also, the abstract neither stated that the research was relevant to the Air Force mission nor did it attempt to explain the appropriateness of Air Force sponsorship of the project. Also, the project was classified by OSR as pioneering research which OSR described, in part, as that for which the usefulness of the results could not be forecast with any degree of certainty.

Pioneering research

Not only has OSR broadly interpreted relevance in selecting the type of subjects that are remote to the Air Force mission, but it has also broadly interpreted relevance in heavily engaging in what it terms "pioneering" research.

OSR stated that, under research of this type, investigators are free to pursue their research without undue concern for the usefulness of their new knowledge.

Examples of pioneering research are provided by the projects entitled "Socio-Cultural Aspects of Development" and "Automatic English Sentence Analysis," which were discussed on pages 13 and 15. Of the 46 projects selected for our review, 24 were classified by OSR as pioneering (see app. I for the identification of these 24 pioneering projects). On the basis of statements made by OSR officials, we concluded that about half of the OSR projects that were active during 1968 and 1969 were of the pioneering type.

The other two types of projects are classified as supporting and connecting, which are described by OSR as follows:

- Supporting research is aimed at acquiring knowledge or understanding needed by development groups to extend capabilities beyond the limits of present technology. Initiation of this type of research is based on a high degree of awareness of Air Force research needs by both the project scientist and the investigator.
- Connecting research consists of research projects in scientific areas which are of interest to the Air Force but which are largely supported by other agencies. By spending relatively small amounts, the Air Force is able to capitalize on the much larger expenditures of others.

Of the 22 projects in our sample that were classified as other than pioneering, 13 were classified as supporting, two were classified as connecting, and the other seven were

classified as combinations of the three classifications. It would appear that, of the three classifications, the supporting classification would be most clearly relevant to the Air Force mission.

Testimony of Air Force officials

In June 1969 hearings before a subcommittee of the House Committee on Appropriations, officials of the Air Force acknowledged that OSR had interpreted the Air Force mission very broadly. With specific reference to an OSR-supported project entitled "Study of Cognitive and Effective Attitudes," the Assistant Secretary of the Air Force (Research and Development) told the House subcommittee that this was not the type of research that the Air Force should be putting its resources into. At the same hearings, with respect to behavioral sciences studies in foreign countries, the Air Force Deputy Chief of Staff (Research and Development) stated, "I agree with [the subcommittee] that too many of these studies have not been relevant in the past, ***."

National Science Foundation

Some of the projects which were undertaken by OSR were of a general nature which would have been supported by the National Science Foundation had funds been available. We observed two instances (one of which was not part of our sample of 46 projects) in which the researcher had first applied to the National Science Foundation and, having been turned down because of lack of funds, applied subsequently to OSR and received support.

In one instance the National Science Foundation advised OSR in September 1964 that it had declined a proposal entitled "Measuring the Gamma Ray Spectrum of Supernova Remnants" because:

*** our stringent budgetary situation during the present fiscal year makes it impossible for us to take on another balloon research project in addition to Stratoscope II at Princeton University.
*** we have told [the principal investigator] in person that it is simply lack of funds,

and not the absence of scientific merit. We advised him to apply to AFOSR and NASA."

In another instance the National Science Foundation informed OSR, with respect to another research proposal entitled "Theoretical Nuclear Astrophysics," that:

"*** we have told [the principal investigator] that lack of money does not permit us to support this new program, and that he might apply to AFOSR or to the AEC."

OSR records showed that it had accepted both of these proposals and that both research efforts were still continuing at the time of our review. A total of \$602,800 has been obligated for the former project and \$99,500 for the latter.

In commenting on our report, the Air Force stated that by including these two cases we were implying that, if the National Science Foundation declined to fund a scientifically acceptable effort, the effort must be inherently irrelevant and therefore unacceptable from the Air Force point of view. We did not intend such an implication but included these cases only to illustrate that research of a general nature and of general interest was brought within the purview of relevance to the Air Force under the Air Force's broad interpretation of relevance.

Relevance based upon 5-year plan

In discussing the general lack of documentation establishing the relevance to the Air Force mission of the 46 projects included in our review, OSR officials advised us that the relevance of each project was established in relation to the Office of Aerospace Research 5-year plan.

We were advised that Headquarters, United States Air Force, had a plan for the accomplishment of the Air Force mission and that part of this plan spelled out the need for research and development; this is amplified by the Office of Aerospace Research 5-year plan which delineates specific areas of research which are relevant to the Air Force mission.

We were not given access to the 5-year plan for the stated reason that it contained financial data for future years. Nevertheless, we were provided with copies of those sections of the plan to which the 46 projects were stated to relate. An illustration of the type of information included in the plan is shown below for that portion of the plan involving the project entitled "Methodology for Analysis of Internal Social Movements," discussed on p. 11.

"Strategic Forecasting and Planning Studies

"These studies should involve interdisciplinary efforts by sociologists, political scientists, economists, and systems specialists in exploratory studies of methods for assembling and handling complex data on foreign social systems and changing world conditions. The use of computer simulation techniques and dynamic models of societies and nations to improve the reliability and accelerate the projection of strategic and historic processes, the specification of the most likely future outcomes, and the description of probable future military environments will be encouraged through the support of research in contributory fields of science. The results of these studies should be presented in forms suitable for a variety of military uses, including planning, training, and future operations. Guidance contained in Air Force planning and technical objectives documents for the period 1967-1982 emphasizes the importance of studies relevant to the military role in dealing with technological, political and economic aspects of strategic interest.

"Such studies will include appraisal of world situations likely to affect the level, and type of intensity of warfare and military strategies for succeeding years; assessment of the capacity of U.S. science and technology to contribute to systems development and the organizational and force structure required to meet future needs; forecasts of the capabilities required by the Air Force in maintaining readiness for engagement in the full

range of military involvements; and capabilities required to support friends and deal with threat and conflict.

"Computer-facilitated studies of critical problems will be encouraged where adequate data are available for making analyses and forecasts; where data on foreign areas are limited, other types of simulation studies will be undertaken."

We believe that each individual contract or grant should be supported by a statement which sets forth the basis on which it was concluded that the expenditure of Air Force funds was warranted. Most of these projects involve expenditures of many thousands of dollars of appropriated funds. It seems completely reasonable, in the light of practices normally followed in the expenditure of Government funds, that a full disclosure be made of the need for the expenditure.

The Air Force informed us that, to improve the documentation of Air Force needs, a new section would be added to the 5-year plan.

AIR FORCE REVIEW OF OSR PROJECTS

Section 203 of the 1970 Defense Procurement Authorization Act, Public Law 91-121, approved November 19, 1969, required that funds authorized by that act be used only for support of projects having a direct and apparent relationship to a specific military function or operation.

On December 2, 1969, the Deputy Secretary of Defense issued a memorandum to the heads of the military services and defense agencies, stating that section 203 was, in effect, reiterative of the legal principles and longstanding policies which had governed and would continue to govern the use of Defense appropriations for research and development activities. He requested a review of all current research projects, to ensure that the longstanding departmental policy, requiring relevance to military missions, had been and was being applied explicitly in every case.

In implementing the Deputy Secretary of Defense's instruction, the Air Force, subsequent to the completion of the GAO review, reviewed all OSR projects by using three levels of review by panels or teams. The panel members were designated from the Office of Aerospace Research Headquarters and field organizations, as well as from Headquarters, U.S. Air Force, and from Air Force Systems Command. The panel members were to classify each project into one of the following categories.

1. Work units considered relevant.
2. Work units considered relevant but inadequately justified.
3. Work units considered irrelevant.

As a result of the Air Force's top management review, 115 OSR research projects were disqualified because of insufficient relevance.

A substantial number of those projects were disqualified because they were more appropriate for support by other agencies, as discussed in the following examples.

Air Force nuclear physics
research program

The Air Force disqualified 26 of the 27 projects in the nuclear physics program. About \$12 million had been expended on these 26 projects. Of this amount, about \$2.3 million had been expended since 1953 on one project--Solar Flare Phenomena and Electromagnetic and Particle Environment of Space Radiation Hazards.

Historically, the Air Force had been involved in research that would develop new nuclear energy and propulsion sources. As stated in the Air Force publication entitled "Air Force Research Objectives 1969," the nuclear physics program was to focus on three areas of importance: cosmic rays, nuclear structures, and high-energy physics. The publication pointed out that the study of cosmic rays was important to the prediction of the severity and duration of radio communications blackouts.

The Deputy for Laboratories advised us that, after reviewing the Air Force's nuclear physics program, he believed that the type of research that the Air Force had been pursuing was not directly related to Air Force functions. For example, although limited areas of nuclear physics research, such as the effect of cosmic rays on communications, were related to Air Force functions, other areas of cosmic ray study for schemes of power generation were not directly related and were properly the function of the Atomic Energy Commission and the National Aeronautics and Space Administration.

Air Force rabies problems--research on
better prevention in Southeast Asia
and other epidemic areas

The research project was related to the development of a better rabies vaccine. The Air Force Office of Aerospace Research had sponsored this research since March 1969 in the amount of \$56,801.

The project was disqualified during the section 203 review, because the review panel felt that rabies was not a unique military problem and that research in this area

should be conducted by the Communicable Disease Center of the National Institutes of Health.

We learned that the National Institutes of Health had been engaged in rabies research for over 30 years and had awarded 29 rabies research grants totaling \$2.3 million over the past 12 years.

Aerospace medical aspects of
rapid diagnosis of disease
and detection of pathogens

The purpose of this research project was to develop techniques for the early detection and identification of viruses and other microorganisms.

It had been sponsored by the Office of Aerospace Research for 5 years in the amount of \$372,201.

According to information provided by the Office of Aerospace Research, the review panel decided that the need for these clinical techniques was not unique to the Air Force, since it would use the techniques in the same way as would a civilian hospital. It was felt that research in clinical techniques was the responsibility of the National Institutes of Health.

INTERNAL AUDIT

OSR did not have an internal audit staff, and Air Force auditors had not reviewed OSR in 3 years. The Executive Director informed us that internal control over OSR's program was exercised through discussions at staff meetings, continual review by supervisors, and presentations at the annual OSR program review. We found, however, that such reviews did not include independent checks of performance.

We were advised in May 1969 that the financial management staff of the Office of Aerospace Research, OSR's parent organization, had started an internal review of certain aspects of management designed to appraise the top management regarding compliance with established procedures for processing scientific reports. Because this review had been recently instituted, we did not evaluate its effectiveness. An Office of Aerospace Research official stated that, as additional staff became available, such reviews would be expanded to cover other areas of activities.

The measures taken by the Office of Aerospace Research should, if properly carried out, help overcome the problems discussed in this report and should ensure more effective performance.

CONCLUSION

OSR interpreted relevance to the Air Force mission very broadly in selecting research projects which it funded. We believe that this situation is due to the fact that neither DOD nor Headquarters, Air Force, provided definitive guidelines for OSR to use in selecting the research projects to be funded. Further, statements of need for the research projects did not adequately establish the basis for funding individual research projects, most of which involved the expenditure of many thousands of dollars.

AGENCY ACTION AND OUR EVALUATION

At the conclusion of our fieldwork, we informally brought our findings and observations to the attention of OSR. In April 1970 we formally brought our findings and proposals for corrective action to the attention of the

Secretary of Defense. We suggested that DOD issue definitive guidelines which would adequately limit the defense agencies and military services to funding projects which were clearly relevant to their missions. These guidelines should also require that, in evaluating the need for funding relevant research proposals, consideration be given to the most appropriate agency to support the research in view of the missions and research performed by other Government and by private organizations.

We also suggested that DOD issue definitive instructions which would require that the military need for each contract and grant be fully disclosed and clearly established in writing and that these justifications be made a part of the official files relating to the contract or grant.

The Director of Defense Research and Engineering replied to our proposals by letter dated June 15, 1970. (See app. II.) DOD said that relevance had always been an established criterion of their research activities and noted that, even prior to enactment of the 1970 act, actions were taken to deemphasize certain areas of research and, in some cases, to transfer projects to other Government agencies. This reply did not directly comment on our proposals for corrective actions by DOD. We were advised, however, of the following corrective actions which were taken by the Office of Aerospace Research subsequent to the discussion of our tentative findings and the passage of section 203.

The Office of Aerospace Research issued a regulation establishing a policy on the criteria to be used in the selection and evaluation of research efforts and revised an existing regulation to incorporate this new criteria in the proposal evaluation procedures. These regulations now require that research proposals be evaluated for relevancy and Air Force need and, more specifically, that each research effort selected for procurement have a direct and coherent relationship to an Air Force function or operation through a technology problem area. These regulations also require an evaluation and determination as to whether each research proposal would be more appropriate for the Air Force than for some other agency.

In response to our suggestion on documenting the military need for research efforts, we were also advised that the revised regulation of the Office of Aerospace Research requires that an official form for documenting the evaluation of relevancy and need be placed in appropriate files. An instruction was also issued for the preparation of this form.

We believe that the actions taken by the Air Force in establishing evaluation criteria and documentation requirements should, if properly implemented, improve the management of the basic research program administered by OSR. We plan to review the implementation and effectiveness of the Air Force criteria and requirements at a later date.

RECOMMENDATION

In view of the similarities in the research programs of the military services and defense agencies, we recommend that DOD take appropriate measures to ensure that each of the military services and defense agencies has consistent and adequate evaluation criteria and management controls.

CHAPTER 3

NEED FOR BETTER SURVEILLANCE OVER RESEARCH PROJECTS

Under OSR's system of management, project scientists are delegated the responsibility for monitoring the work on OSR-sponsored research projects. One of the objectives of this monitoring is to ensure that the research group does the work it agreed to perform and does not deviate unduly from agreed objectives and negotiated budgets. Our review of 46 projects disclosed that OSR's informal monitoring procedures were not consistently and uniformly followed, and we believe more effective monitoring could have prevented certain administrative problems and major deviations from agreed objectives and budgets.

OSR REQUIREMENTS PROVIDE FOR MONITORING

OSR operating requirements provided for visits to the project site by the OSR scientist responsible for the project and charged the scientist with responsibility for seeing whether the agreed amount of scientific effort was being devoted to the work OSR was sponsoring. Inherent in OSR instructions was the requirement that major deviations from agreed objectives and negotiated budgets be acceptable to, and approved by, OSR.

The only written guidance on how this monitoring was to be performed, other than the general requirements cited above, was contained in OSR Headquarters Operating Instruction 80-1, dated November 13, 1964. It set forth OSR policy which stated that the amount of time proposed to be devoted to a research project by scientific personnel was one of the principal determinative factors in the selection of proposals to be sponsored. The instruction provided for OSR scientists and contracting officers, during each visit to research sites, to inquire whether the proposed amount of scientific effort was being devoted to the projects.

Beyond this instruction, OSR scientists were not provided with written guidance on how monitoring was to be performed or on documentation of the monitor's observations and of the agreements he reached with the research group.

Generally, good monitoring requires periodic visits to the project site, written postvisit reports on the results thereof, and analysis of technical and nontechnical reports submitted by the contractors and grantees to inform Government scientists and contracting officers on the status and progress of research work. Good monitoring also includes systematic consideration of the work being done to ensure that the contractor or grantee is complying with the terms of the agreement and the recording of deviations in writing for resolution.

MONITORING NOT DONE CONSISTENTLY AND UNIFORMLY

We found that, to some extent, OSR scientists complied with the informal standards by visiting domestic contractors at least once a year and by obtaining annual reports on the progress of the research projects. These procedures, however, were not consistently and uniformly followed. We observed cases where some or all of the monitoring standards were not met. For example, we found that OSR scientists had not obtained progress reports for the most recent period of support from four of the 46 research efforts we reviewed, because a progress report had not been requested.

Also, we found that, during the year prior to our review, four of the 36 domestic projects we reviewed had not been visited. Several of these projects involved problems in meeting grant and contract obligations with respect to completing the research and submitting scientific reports to OSR. Moreover, we found that generally OSR did not require its project scientists to make written postvisit reports on matters observed or agreements made. Contract and grant files maintained by OSR scientists for 26 of the 35 projects visited in the last year prior to our review contained no written record of discussions held or agreements made during the project site visits. Several scientists stated that they follow the practice of orally reporting significant matters observed during site visits.

EXAMPLES OF ADMINISTRATIVE PROBLEMS

The four projects below illustrate the need for additional practice of consistent and uniform monitoring. Had

monitoring procedures been more consistently followed, we believe that problems and deviations from contract agreements could have been disclosed, providing greater assurance that research funds were being used effectively.

Algebraic Theory of Machines

In 1965 OSR awarded a 1-year contract for \$25,644. This contract was negotiated on the basis that the principal investigator would devote half of his time to this research, for which he was to receive \$7,500. OSR extended the contract in 1966 and 1967. In each case, the principal investigator proposed to devote 6 months of his time at a cost of \$8,000. The contract involved over the 3-year period a total of \$79,000 of which \$23,500 was proposed and negotiated specifically for the effort of the principal investigator for 18 months of his time. Upon completion of the contract, however, the principal investigator advised OSR that he had devoted only 2 months at the outset of the research and that 16 other persons had been working at various times on this research.

The current OSR project monitor stated that he had never met these persons and did not know their qualifications. OSR project files contained no indication that during the life of the contract OSR scientists had detected that the principal investigator did not live up to his proposed budgets. OSR officials told us they became aware in June 1967 that the principal investigator had too many other research commitments and notified the principal investigator in August 1967 that OSR probably would not renew the present contract.

The OSR project scientist currently responsible for monitoring this effort advised us that he had not made any visits to the contractor, although the contractor was located in Washington, D.C., and that the project had not been visited by OSR personnel since June 1965. He told us that visits to the research site in this case were not considered necessary because the principal investigator had visited OSR on several occasions and also had submitted progress reports. It appears that these visits and progress reports alone are not adequate to keep the project scientists properly informed.

Had visits to the research site been made and had inquiries been made as to whether the proposed amount of scientific effort was being devoted to the project, as required by OSR Headquarters Operating Instruction 80-1, we think that the contractor's deviation from the agreement with OSR would have been detected much earlier.

Cosmic Radiation of Extremely High Energy

The files on this project contained no evidence that significant deviations, made by the grantee from the negotiated budget, had been made known to OSR or were done with the knowledge and approval of the project scientist and the contracting officer. OSR had supported this research project since 1964 and had expended or authorized \$458,000 thereon. The initial grant for \$178,000 was solely for the purchase of equipment to help build 100 stations for observing cosmic ray showers.

Prior to the award of the grant, the grantee specifically agreed to adhere to the negotiated budget and agreed to bear all labor costs associated with the construction of the stations. We were informed, however, that only 34 of the proposed 100 stations were built with funds provided under this grant and that a portion of funds was used for payment of salaries of researchers.

Although OSR scientists had visited the research site in July 1965, November 1966, and May 1967, they could not explain the reasons for the deviation. The contracting officer responsible for this grant at the time of our review stated that he could find no evidence that the grantee had requested and that OSR had given approval for deviation from the negotiated budget. After we brought this matter to the attention of OSR's officials, several letters were sent to the grantee requesting explanations of the use of grant funds.

OSR officials told us that they were aware of this deviation from the agreed budget through the periodic fiscal reports submitted by the grantee and that acceptance of these reports indicated OSR approval of this change. We noted, however, that the fiscal and progress reports prepared by the grantee did not explain the reasons for

deviating from the agreed budget, as required by OSR grant provisions. Moreover, there was no evidence in project files that, prior to our review, OSR had investigated this matter, despite the fact that OSR personnel visited the grantee--located at a distance of some 10,000 miles from Washington, D.C.--during the time the deviation occurred. There were no postvisit reports prepared for the visits in 1966 and 1967.

The Air Force advised us that, despite deviation from the budget, responsible program managers were satisfied that the overall objectives for which the DOD research money was expended were met. The fact remains, however, that the Air Force did not get 66 of the 100 stations that were proposed to be built with these funds and that this matter was never brought up for consideration at top management levels despite three monitoring visits.

To the extent that the OSR monitoring activities of this project did not result in necessary information being obtained during project visits and being appropriately documented to provide a basis for management and procurement actions, OSR resources--research funds, time of project scientists, and the travel funds involved in the three visits--were not being efficiently utilized. We believe that systematic considerations of the work being done during visits and that recording deviations in writing for resolution would have assured more prompt consideration of the deviations in this case.

Theoretical Research in Astrophysics

OSR supported this project from June 1960 through September 15, 1967, at a cost of \$274,000. According to project files and OSR officials, progress and postvisit reports were not prepared. A memorandum to the files showed that OSR's monitor evaluated the progress of the research in January 1966 and concluded that the research objectives were so general that it was difficult to determine what was to be done or whether anything had been accomplished. He stated:

"The proposals received from the university for this effort have in general been unsatisfactory *** since the documents are not complete. For instance, the proposal dated 15 January 1964, did not provide a review of previous work with citation of papers published. The work to be pursued in the continuation of the support for the next two years was described only in a general way. The document states 'Work under the current grant has been supporting graduate students and research associates working in astrophysical subjects.' The last status report describes the subjects that are at the moment under investigation. The detailed projects will, of course, change depending on developments in the subjects and on student and faculty interest."

The project monitor informed us that OSR subsequently declined to further support the project because of the broadness of the research work and the tight budget.

We believe that the \$274,000 might have been used more effectively if there had been systematic evaluation of progress during the visits and use of postvisit reports to inform OSR managers of problems occurring under the contract.

Theoretical and Experimental Studies in Magnetohydrodynamics and Plasma Physics

OSR awarded a 5-year grant for \$66,667 to a university in 1963 to provide two-thirds of the salary for a professor of space sciences to help the university establish a department of aerospace sciences. The research proposal listed

several research objectives to be accomplished. We found, however, that OSR had not received any fiscal and scientific reports in the 5-year period the grant was in existence and that progress reports had not been submitted subsequent to December 1966. A letter submitted by the grantee in May 1968--4 months before the grant was to expire--was accepted by OSR in 1969 as a final scientific report required under the terms of the grant.

We found also that OSR project monitors had not visited the grantee, located in Washington, D.C., for a 3-year period and had not followed normal monitoring procedures with respect to this grant. Under these circumstances there was a lack of assurance that the research objectives were being achieved.

OSR officials advised us in October 1969 that the "contribution from the grant was important and considerable" and that, in their opinion, the grant was a success. The research group headed by the principal investigator had produced a number of scientific reports.

CONCLUSIONS

We believe that OSR can provide greater assurance that deviations will be detected promptly by establishing firm requirements for periodic progress reports from researchers; for mandatory visits, at least annually, to research projects for purposes of ascertaining scientific progress and possible problems; and for written reports on observations made during such visits, with particular attention to deviations from agreed objectives and negotiated budgets and problems in meeting established contractual obligations. We believe that written monitoring requirements, if carried out consistently and uniformly, would enhance management control over the research grants and contracts, would facilitate appropriate administrative action, and would provide better protection of the interest of the Government.

AGENCY ACTIONS AND OUR EVALUATION

To improve the effectiveness in maintaining surveillance over research projects, we suggested that OSR require contractors and grantees to submit periodic progress reports.

We proposed also that OSR issue guidelines to its project scientists establishing a minimum interval between visits to research project sites, specifying the aspects that should be evaluated during each visit to a grantee and contractor and requiring that all visits be appropriately documented to cover such matters as significant observations made, results of discussions held, and an evaluation of progress to provide a basis for management and procurement actions.

Commenting on our suggestions, the Air Force informed us in June 1970 that the OSR had issued instructions in April 1970 requiring contractors and grantees to submit an annual report containing a statement on research progress, listing of publications, and contemplated major deviations in program and budget. The Air Force also informed us that appropriate procedures have been issued in February 1970 requiring a minimum of one visit to the research project site each year. The procedures also contain guidelines for information to be obtained on each visit and a requirement for trip reports documenting the results of these reviews.

We believe that these measures, if properly implemented and sustained, will enhance management control over the OSR research program.

CHAPTER 4

RESEARCH RESULTS NOT OBTAINED

OR NOT OBTAINED PROMPTLY

OSR project scientists are required to ensure timely receipt of the scientific reports produced under the research that OSR sponsors. In the 46 projects we examined, we found that, in 22 projects, all published reports had not been received and that long delays ensued between completion of the reports and their submission to OSR. In 23 cases, OSR scientists had not made appropriate checks to see whether all reports had been received.

SCIENTIFIC REPORTS MUST BE SUBMITTED TO OSR PROMPTLY

Because OSR recognizes that scientific reports are its primary products, its policy is that such reports must be submitted to OSR promptly so they can be appropriately utilized to reduce the leadtime between discovery of new knowledge and its application to the advancement of aerospace technology and to the maintenance of Air Force operational superiority. The procedures which OSR had issued to implement this policy provided that grantees and contractors submit scientific reports to OSR in the required number of copies immediately following publication. OSR project scientists were responsible for assuring that all scientific reports produced under OSR-sponsored research had been received.

To ensure that all such reports had been received and processed promptly, OSR Headquarters Operating Instruction 80-3, dated September 17, 1966, required project scientists to check listings of research results that the grantees and contractors were expected to submit.

REPORTS NOT RECEIVED OR DELAYED UNDULY

We found that in 23 of the 46 projects we reviewed, OSR scientists had not always checked the listings of reports produced to see whether all of the reports had been received by OSR. In eight instances OSR's files were not complete, and we could not make a conclusive determination

as to whether all reports issued by the researcher had been received by OSR. In 22 other instances, however, we found that one or more of the reports either had been received by OSR only after a long delay or had not been received at all.

According to the Air Force, the reports which had not been received represented about 7 percent of the documents that should have been included in OSR files.

For example, upon completion of the research effort entitled "Political Development and Modernization in Islamic Countries: Military Planning," supported by OSR for \$64,140, the principal investigator reported that 11 articles and monographs had been published during the period 1964 through June 1968. OSR records showed that only one report, published in 1964, had been received by OSR as of February 1969. The cognizant OSR scientist advised us he was aware that several papers had been written but that he would ask the principal investigator for copies of all reports published when the final scientific report was received by OSR. Records show that, during February through June 1969, OSR received and sent to the Defense Documentation Center 10 reports that had been published in the period 1964 through 1967. Some examples of the reports that were delinquent follow:

<u>Title</u>	<u>Year of publication</u>	<u>Date of receipt by OSR</u>
Ideological Foundations of Egyptian-Arab Nationalism	1964	Feb. 1969
Egypt: The Integrative Revolution	1964	Feb. 1969
The Proofs of Islam: Religion and Politics in Iran	1965	Apr. 1969
Political Change in Lebanon	1966	June 1969
The Tragedy of Syria	1967	May 1969

OSR officials told us that the principal investigator had not sent manuscripts of the 10 delinquent reports to OSR, although OSR procedures required that a manuscript copy be furnished at the time the report was sent to the publisher.

In another case involving a research project entitled "Atomic Chemistry," supported since 1961 at a cost of \$492,000, scientific reports published during 1967 were not furnished to OSR for purposes of appropriate distribution until December 1968. OSR officials advised us that these reports were delinquent because of administrative problems encountered by the grantee during a half-year absence of the principal investigator.

OSR officials acknowledged the fact that there were some delays in receiving reports because of known built-in publication backlogs of up to 2 years. They pointed out, however, that they considered direct contact of interested scientists at professional meetings, seminars, and conferences as the primary method of disseminating research results. For this reason they do not regard delays in receiving published reports as a severe impediment to the dissemination of scientific knowledge. They stated that, if OSR project monitors recognized a subject or an idea that was of concern to an Air Force laboratory, the monitors could immediately send manuscript copies to such users.

OSR scientists did not know, however, whether all principal investigators supported by OSR periodically present their achievements in professional meetings and seminars. Moreover, as stated on page 36 of this report, we found that OSR did not always receive manuscripts of reports and, in the examples described in this section, the OSR scientists could not or did not forward manuscript copies of the delinquent research reports to other Air Force scientists and laboratories. In view of the high cost of producing research results, prompt receipt of all scientific reports by appropriate Government recipients is necessary to realize maximum return on the investment.

CONCLUSION

When scientific reports are not received promptly or when delays in obtaining them are experienced, research results cannot be effectively evaluated and disseminated by OSR, and the return on these results may not be fully realized or its realization may be delayed. Although dissemination of scientific research results may take place

through the less formal methods at professional meetings and symposia, we believe this should not be a reason for OSR scientists to permit such delays in receiving reports as described in this chapter. We believe that OSR procedures established to ensure prompt receipt of the results of research sponsored are generally sound and well conceived. What is needed is more vigorous implementation of these procedures.

AGENCY ACTIONS AND OUR EVALUATION

To improve the effectiveness in achieving maximum return on the millions of dollars invested annually in basic research, we suggested that OSR place greater emphasis on implementing existing procedures with respect to obtaining promptly all scientific reports produced under the research projects supported.

The Air Force informed us in June 1970 that OSR procedures had been augmented in April 1970 to include a review of listings of publications in the annual progress reports. Also, an OSR official had been given responsibility for monitoring the compliance with this procedure.

We believe that these measures, if carried out consistently and uniformly, will ensure prompt receipt of the results of research sponsored by OSR.

CHAPTER 5

NEED FOR MORE EFFECTIVE DISSEMINATION

OF RESEARCH RESULTS

The results of research projects sponsored by the Air Force are to be promptly disseminated to those responsible for developing Air Force weapons and technology as well as to other interested governmental organizations. Making research results available to such persons and groups is necessary if the fruits of research are to be used effectively. We found, however, many instances in which published research results either were not directly made available to interested parties or were made available only after long delays. OSR did not make prompt dissemination of these published results because its operating procedures were not effective enough to ensure that research results were uniformly disseminated on a timely basis.

INFORMAL DISSEMINATION OF RESEARCH RESULTS

The requirements for dissemination of research results obtained by OSR were contained in Air Force Regulation 80-4, dated April 11, 1966, and Regulation 23-18, dated January 31, 1968. These regulations required that the results of Air Force-sponsored research be effectively disseminated to those responsible for the development of improved aerospace technology, weapons, equipment, and operations. Air Force Regulation 80-4 and the Office of Aerospace Research command policy provided that publication of results in scientific journals be encouraged and required that copies of findings and results be furnished promptly to the Defense Documentation Center so that the data would be available for secondary distribution to all eligible users. Office of Aerospace Research policy also provided for review of existing distribution lists for currency so that appropriate initial distribution of reports could be held to a minimum.

As discussed in chapter 4, OSR could not have accomplished effective distribution of research results in a number of instances because it did not obtain research results

promptly. In addition, we found that, even when results were obtained by OSR, they had not always been disseminated promptly or in an appropriate manner. In this respect, in 23 of the 46 projects we examined, OSR project scientists had not distributed the scientific reports obtained directly to selected potential prime users within the Air Force or in other agencies. Also, reports in certain instances were not sent to the Defense Documentation Center for secondary distribution to other interested users as required by regulations.

For example, the final report received in February 1968 and certain manuscripts of journal articles produced in September and December 1968, under a project entitled "Quadratically Nonlinear Differential Systems," were not sent to selected Air Force users or to the Defense Documentation Center even though this project had cost the Government \$76,000. The Air Force advised us in June 1970 that the results of this project had been presented at a scientific meeting in January 1969 and an article had been published in March 1970. We do not believe that this could be considered adequate and effective dissemination of research results to potential Air Force and other governmental users.

In another example, the cognizant OSR scientist approved reports produced under a project entitled "Studies of Psychotomimetics" for distribution to the Defense Documentation Center, but he did not send reports directly to selected potential users in the Air Force or in other agencies. He stated that he would not consider such distribution unless the results involved a major new discovery and felt that making the results available through the Defense Documentation Center was adequate distribution. A total of \$29,000 had been expended on this effort.

OSR records showed that about \$8.8 million in Government funds were spent to obtain the scientific reports, produced by the 23 projects, that were not distributed to selected interested parties.

In our review of OSR's operating instruction, we found one reason why selective initial distribution may not have been made. OSR Headquarters Operating Instruction 80-3, dated September 12, 1966, dealing with dissemination of

research results, stated that each division chief and project scientist would:

"Take appropriate steps to exploit ideas appearing in manuscripts by referring them to other interested agencies or to the AFOSR Assistant Executive Director, Research Communication (SRGC)."

This instruction did not specifically provide for selective distribution of results or notification of the existence of such results to "those responsible for the development of improved aerospace technology" as specified by Office of Aerospace Research policy, and we found that OSR did not maintain listings of selected potential users for all projects. Consequently, OSR's operating procedures would not have produced results in consonance with the information supplied for the record by the Director of Defense Research and Engineering to the Senate Foreign Relations Committee,¹ in which it was stated:

"There is prompt initial distribution of research reports to those individuals and offices concerned with the subject matter and to all to whom the information contained could be immediately useful."

Since the basic research program supported by OSR is to be based on the Air Force's needs as identified by Air Force scientists from various inputs provided by all Air Force research and development and operational elements, the results should be made available--in addition to other methods of dissemination--directly to Air Force elements most interested in such research if the research is to produce tangible results for the Air Force. Accordingly, it would seem that many of the benefits of the research might be lost if prompt distribution was not made to those Air Force groups having most interest in the subject matter covered by the research.

¹Hearing before the Committee on Foreign Relations, U.S. Senate, on "Defense Department Sponsored Foreign Affairs Research," May 9, 1968.

The need for such selective distribution has been recognized by some OSR project scientists. For example, the scientist monitoring a project entitled "Feasibility Study of the Fluid Transpiration Arc" maintained a list of recipients who were to receive scientific reports produced. Among the recipients were the Air Force Cambridge Research Laboratories, Aerospace Research Laboratories, and other laboratories.

We recognize that other methods of disseminating research results--scientific meetings, use of abstracts, indexes, and the like--are available and, in many instances, are used to supplement the more formal distribution channels. In view of the amount of money spent on support of basic research each year, however, we believe that informal methods of dissemination should not supplant the more formal methods.

We found that the management at OSR did not recognize a need for systematic distribution of research results to selected potential users in the Air Force. The Executive Director advised us that the information network in the scientific and technical community was sufficient and that information was disseminated very rapidly within the scientific community through scientific journals. He expressed the belief that the existing flow of information could not be accelerated to any significant degree.

Also, we found that OSR project scientists believed that results of basic research were quickly and effectively disseminated through the information channels available among peers in the scientific community. For this reason, they generally regard a formal method of distribution as unnecessary. Some scientists have indicated that publication in scientific journals is sufficient to assure adequate distribution of results of basic research.

In discussing utilization of selected scientific reports with several users who had requested these documents through the Defense Documentation Center data bank, however, we were advised that, owing to the vast number of scientific journals and the volume of reports published therein, it was not possible to keep up with all that was being published. This view was shared also by several OSR scientists who

stated that the volume of scientific literature had grown to such proportions that one could not read it all.

The inadequacy of current methods of dissemination was pointed out in a May 1968 report of the Subcommittee on Science and Technology to the Senate Committee on Small Business, which stated that the transfer of technical knowledge occurred slowly and sporadically without some deliberate effort to accelerate its flow. Thus, it would seem that the need for channeling of research results to selected potential users was great.

CONCLUSION

We believe that the effective use of research results will be enhanced by making scientific reports directly available to selected Air Force research organizations responsible for developing Air Force weapons and technology. It would seem that OSR scientists, who selected the research projects based presumably on the research needs of the Air Force, were also in the best position to determine which Air Force organizations had the most interest in the results of such research and should receive copies of scientific reports, as contemplated in the Office of Aerospace Research command policy on published documents. Although other less formal methods may also be used in the dissemination process, we believe that OSR procedures, with respect to dissemination of scientific results, should be expanded to require that results of research be distributed on a systematic but selective basis to designated potential users.

AGENCY ACTION AND OUR EVALUATION

To improve the effectiveness in achieving maximum return on dollars invested in research, we suggested that OSR issue instructions requiring OSR scientists to make the results of research projects promptly available to those Air Force organizations having the most interest in such results.

The Air Force informed us in June 1970 that, subsequent to our review, appropriate procedures had been issued requiring distribution of scientific results to selected

personnel and organizations. In addition, OSR has designated the use of specific forms for rapid dissemination of information with current developmental potential.

We believe that these actions, if properly implemented and sustained, will enhance the effective use of research results.

CHAPTER 6

SCOPE OF REVIEW

Our examination of the management of the basic research program administered by OSR included a review of the laws and policies which govern the conduct and support of basic research by Federal agencies. The review was directed toward examining the effectiveness of management controls within the OSR and the Air Force Office of Aerospace Research, including procedures, records, and internal reviews relating to the evaluation and selection of research proposals, surveillance over research projects, and evaluation and utilization of scientific reports resulting from research projects supported. We did not review the terms of the contracts and grants for compliance with Government procurement regulations.

In our review we inquired into the circumstances surrounding the selection, surveillance, and utilization of results of 46 of the approximately 1,200 research grants and contracts administered by OSR during the period of our examination. Our selection included projects from each of the six OSR divisions with an emphasis on behavioral and social science projects. Our inquiry into the 46 contracts and grants included a review of OSR files regarding these contracts and grants and discussions with involved personnel of OSR.

Our review was conducted at OSR and at the Air Force Office of Aerospace Research, both located in Arlington, Virginia.

APPENDIXES

LISTING OF 46 PROJECTS REVIEWED

<u>Title of project</u>	<u>Scientific area related to Air Force mission</u>	<u>General type of project</u>
DIRECTORATE OF LIFE SCIENCES:		
1. Preparation of Manuscript for a Reference Book on Laboratory Animal Diseases	Microbiology	Connecting
2. Studies of Psychotomimetics	Pharmacology	Supporting
3. Anatomical and Physiological Studies on the Nervous System	Physiology	Supporting
4. Physiology of Cerebrospinal Fluid in Primates	Pharmacology	Supporting
5. Genesis of Action Potentials in Excitable Tissue	Bionics	Supporting
6. Political Development and Modernization in Islamic Countries--Military Planning	History, law, political science	Supporting
7. Influence of Campus Environment on Student Commitment to the USAF ROTC	Sociology	Supporting
8. Methodology for Analysis of Internal Social Movements	Sociology	Supporting
9. Perception of Dynamic Stimuli	Psychology	Supporting
10. Criteria for the Design of New Forms of Organization	Sociology	Supporting
11. Sociocultural Aspects of Development	Social Psychology	Pioneering

<u>Funds authorized for project</u>	<u>Status of project in November 1969</u>	<u>Statement of relevancy of project to Air Force mission as presented by OSR</u>
\$ 82,120	Active	This book will aid in the diagnosis, prevention, and treatment of spontaneous illnesses of research animals. It will also be useful in evaluating experimental results by helping to differentiate between spontaneous and experimentally induced lesions. Its long-term value will be to point up areas where more research is needed. The results will be relevant to the extensive use of animals in Air Force research.
28,920	Completed	This study is exploratory in this context and relates to military interests in these matters.
151,111	Completed	These studies are relevant to Air Force studies of the effect of the multiple stresses of the aerospace environment on the body.
17,605	Completed	All of these topics are related to the bodily response to stressful conditions and adjustment to hostile environments.
109,050	Completed	The results are important for understanding how biological membranes work and how nerves respond and are of interest to engineers.
64,140	Completed	The proposed research will be an investigation of the relation between national integration and political development. These studies bear directly on the role of the U.S. military in providing military advice, assistance, and advanced training in U.S. military schools for the indigenous military leaders and on the problems of long-range military planning.
147,558	Completed	The purpose of this research is to investigate the relationship between organizational attributes of the Air Force Reserve Officers' Training Corps at a university and the patterns of recruitment, retention and leadership attainment in the cadet population. Comparison of students who enter the Corps and those who do not, of cadets who differ in duration of Corps career and cadets who differ in level of leadership attainment will be utilized to discover longitudinal processes of commitment of the Corps, as these are affected by its internal social structure and its external organizational environment.
201,861	Active	With the techniques being developed and tested it will be possible to take advantage of computers to analyze more complete data than would otherwise be manageable. Results will be useful for environmental and political analysis and forecasting by Air Force systems planners.
222,380	Completed	The results of this investigation will be applicable to a wide variety of situations in which the operator is called upon to respond in some fashion to the velocity and acceleration of visual stimuli.
176,774	Active	This handbook will be especially useful to the Air Force and other military supervisory staffs engaging in the planning of organizational change and adaptation to new conditions.
82,920	Completed	This knowledge will be very useful in guiding programs for military aid and policy planning.

LISTING OF 46 PROJECTS REVIEWED (continued)

<u>Title of project</u>	<u>Scientific area related to Air Force mission</u>	<u>General type of project</u>
DIRECTORATE OF INFORMATION SCIENCES (continued):		
12. Automatic English Sentence Analysis	Linguistics	Pioneering
13. Evolutionary and Multilevel Information Processing Networks	Bionics	Pioneering
14. Contributions to an Understanding of the Language Communication Process	Linguistics	Pioneering
15. Languages for Automatic Programming Tools	Linguistics	Pioneering
16. Cybernetic Model of Learning and Perception	Bionics	Pioneering
17. Selection of Variables in Clustering and Pattern Recognition	Documentation, information technology	Pioneering
18. Problems in Machine Problem Solving	Linguistics	Pioneering
DIRECTORATE OF CHEMICAL SCIENCES:		
19. Bibliographic File of Abstracts on Photographic Science	Inorganic chemistry	Supporting, Connecting
20. Analysis of Electron Scattering from Atoms and Molecules	Physical chemistry	Pioneering, supporting
21. Flame Spectrometry and Gas Chromatographic Detectors	Physical chemistry	Pioneering, supporting, connecting
22. Atomic Chemistry	Organic chemistry	Pioneering
DIRECTORATE OF ENGINEERING SCIENCES:		
23. Selected Problems in the Theory of Electromagnetic Radiation	Wave propagation	Pioneering

<u>Funds authorized for project</u>	<u>Status of project in November 1969</u>	<u>Statement of relevancy of project to Air Force mission as presented by OSR</u>
\$261,001	Active	Research results should furnish an understanding of how computers may be used for natural language analysis for such applications as text compression, extracting, indexing, and translation.
162,621	Active	The research is expected to disclose methods of improving the information processing capabilities of computers for automatic pattern recognition and circuit design.
41,500	Active	Research results will be examined for their applicability to the problem of partial understanding as it arises in human communication. This research has direct relevance to the solution of practical communication problems as well as to the need for effective natural language processors in man-man and man-machine systems.
20,600	Active	The research is expected to add to an understanding of fundamentals of the pragmatics of language, i.e., those relationships that exist between signs and symbols and those who produce and use them.
93,778	Completed	This work is basic to the development of intelligent machines that can be of use in Air Force command and control systems and in operational environments where control and decision processes are required with a minimum of human intervention.
159,291	Active	Research results are expected to show how to reduce the amount of computation required for the discrimination of large numbers of objects for such applications as target recognition and weather forecasting.
259,620	Active	This research is clarifying the language requirements for describing problems and methods of solution toward formulation of maximally efficient specifications for machine problem solvers.
106,859	Active	A system was set up 12 years ago under OSR sponsorship which proved quite useful to the Air Force. This new system will extend the former system from 1958 through 1967 and be compatible with it.
312,032	Active	Use will be made of techniques developed in this research for studying aerospace vehicular hardware.
389,091	Active	The development of the flame fluorescence spectrometric analysis method by the principal investigator has made this new technique a candidate to replace emission spectroscopy in the rapidly expanding Spectrometric Oil Analysis Program (SOAP) of the Air Force as applied to the maintenance of aircraft engines.
492,276	Active	This research will open up a completely new area of chemistry and should make available new materials for Air Force applications.
549,074	Active	This research provides highly relevant fundamental knowledge supporting Air Force efforts in electromagnetic pulse, turbulence, antenna, and propagation problems.

LISTING OF 46 PROJECTS REVIEWED (continued)

<u>Title of project</u>	<u>Scientific area related to Air Force mission</u>	<u>General type of project</u>
DIRECTORATE OF ENGINEERING SCIENCES (continued):		
24. Basic Research in Electronics	Components	Pioneering
25. Mechanics and Thermodynamics Research	Solid mechanics	Pioneering
26. Feasibility Study of the Fluid Transpiration Arc	Fluid mechanics	Pioneering
27. Stability and Transition of Laminar Boundary Layer	Fluid mechanics	Supporting
28. Solid Propellant Ignition Studies	Combustion and ignition	Supporting
29. Collision Cross Sections for Momentum Transfer in Plasmas	Plasma physics, conversion techniques, fusion devices	Supporting
30. Experimental Aerodynamics	Fluid mechanics; thermodynamics	Supporting
31. Theoretical and Experimental Studies in Magnetohydrodynamics and Plasma Physics	Plasma physics	Connecting
DIRECTORATE OF MATHEMATICAL SCIENCES:		
32. Quadratically Nonlinear Differential Systems	Mathematics	Pioneering
33. Conformal and Variational Methods	Mathematics and statistics	Pioneering
34. Basic Research in Ordinary and Partial Differential Equations and Special Functions	Mathematics and statistics	Pioneering
35. Algebraic Theory of Machines	Applied mathematics	Pioneering

Funds authorized for project	Status of project in November 1969	Statement of relevancy of project to Air Force mission as presented by OSR
\$1,625,000	Active	This research is relevant to a significant number of published technical objectives. Special emphasis is placed on technical domains of bionics, lasers, molecular electronics, electromagnetic propagation, and plasmas. This work has special relevance to data storage systems.
151,244	Active	The results of this research will lead to new, simpler methods of analyzing the mechanical and thermal stresses of flight vehicles and will suggest ways of building more reliable and efficient structures.
646,635	Active	The feasibility of applying the results of this work to more realistic and practical solar simulators is being studied.
1,392,833	Active	This effort is relevant to the phenomenon of transition from smooth air flow to turbulent air flow along a flight vehicle's surface.
351,209	Completed	This study will increase understanding of ignition processes and lead to improved design or scaling criteria for solid propellant igniters and rockets.
390,437	Completed	Plasma constituent interaction forces represent one of the basic parameters required to predict the performance and characteristics of plasma devices, such as propulsion accelerators, electrical power generators, and controlled fusion energy sources. Present data in this area is uncertain and conflicting. This program seeks to improve the accuracy of this area. Results of this work were published in the AIAA Journal and Physics of Fluids.
163,880	Active	This research is relevant to the design of future high supersonic and hypersonic Air Force flight vehicles.
66,667	Completed	The objective of this project is to carry on fundamental, theoretical, and experimental work in magnetohydrodynamics and plasma physics.
76,347	Completed	Emphasis is on developing new and better methods for finding solutions to differential equations generated by advanced Air Force systems development.
631,630	Completed	This research is fundamental to the better understanding of differential equations, both ordinary and partial, particularly those types of equations that arise in the study of aerodynamics, electrodynamics, control theory, and communication theory.
411,900	Active	This research will contribute significantly to our fundamental knowledge in those areas of technology where the Air Force has a demanding need, especially in communication theory, diffraction theory, and radar.
79,384	Completed	The objective is the decomposition of these systems to their irreducible structure to provide better understanding and more efficient design and utilization.

LISTING OF 46 PROJECTS REVIEWED (continued)

<u>Title of project</u>	<u>Scientific area related to Air Force mission</u>	<u>General type of project</u>
DIRECTORATE OF MATHEMATICAL SCIENCES (continued):		
36. Research in Algebraic Theory of Machines	Mathematics and statistics	Pioneering
DIRECTORATE OF PHYSICAL SCIENCES:		
37. Low-Level Earth Motion	Seismology	Pioneering, supporting
38. Theoretical Investigations in Quantum Field Theory and Elementary Particle Physics	Particle physics	Pioneering
39. Theoretical Research in Astrophysics	Electromagnetics and electron physics	Pioneering
40. Radioactivity of Some Unusual Celestial Energy Sources	Particle physics	Pioneering, supporting
41. Relaxation Mechanisms and Gas Laser Media	Wave propagation	Pioneering
42. Experimental Low Energy Nuclear Physics	Particle physics	Pioneering, connecting
43. Electron and Nuclear Spin Interactions in Solids	Solid state physics	Pioneering
44. Operation of Accelerator-Storage Ring to Provide Ultraviolet Radiation	Solid state physics	Pioneering, supporting
45. Electronic Properties of Solids	Solid state physics	Pioneering
46. Cosmic Radiation of Extremely High Energy	Particle physics	Pioneering
Total		

<u>Funds authorized for project</u>	<u>Status of project in November 1969</u>	<u>Statement of relevancy of project to Air Force mission as presented by OSR</u>
\$ 63,609	Completed	This theory is applicable to finite state systems. It will provide a representation of discrete input sequential machines, e.g., digital computers, which will permit more efficient utilization of present machines and guidelines for future machines. It has applications to systems theory, biology, molecular chemistry, programming, and many areas of interest to modern science and aerospace technology.
2,447,742	Completed	This research is directed to a study of the manner in which the earth responds to low-level energy sources. The objective is to measure and understand the earth's responses to these sources.
96,000	Active	This work is essential to an understanding of the fundamental properties of matter. Such an understanding is needed before further breakthroughs in weapons technology can be achieved.
274,300	Completed	This research involves a study of magnetohydrodynamics, with emphasis on the role of molecular and atomic hydrogen in astronomical space and on bodies in the solar systems, and the motion of interstellar and interplanetary grains. The results will assist in revising current theories concerning these objects.
602,795	Active	These flights provide useful information on the background fluxes of gamma rays in the environment where many future Air Force systems will operate.
520,013	Active	The research will allow gas lasers to be developed with improved efficiencies and power and operating at wavelengths from the infrared to the ultraviolet to be used in communications, radars, and illumination applications.
4,241,203	Active	The work provides the fundamental basis for future Air Force special weapons and energetics.
1,370,409	Active	The goal is improved understanding of electronic properties of known materials and prediction of new materials with properties of use in future Air Force detection and communication devices.
326,814	Active	This understanding will facilitate the design of radiation sensors over a large portion of the electromagnetic spectrum.
1,042,639	Active	The electronic energy states in solids and their response to magnetic and strain fields are studied using intense synchrotron radiation to aid in the development of new solid state materials. Charge transport by means of tunneling through barriers and between impurities is studied at cryogenic temperatures to explain contact phenomena in solid state devices and to increase understanding of transport processes in metals, semiconductors, and insulators.
<u>458,300</u>	Active	These investigations are already yielding much new knowledge on the structure of our universe, the environment in space, and the properties of matter at extremely high energies.
<u>\$21,503,172</u>		



DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D C 20301

Honorable Charles M. Bailey
Director, Defense Division
United States General Accounting Office
Washington, D. C. 20548

15 JUN 1970

Dear Mr. Bailey:

This letter and its attachments provide comments, recommendations, and actions taken concerning the GAO Draft Report entitled "Need to Strengthen Management Control Over the Basic Research Program Administered by the Air Force Office of Scientific Research."

The following comments are made relative to the GAO recommendation that DoD issue definitive criteria which will ensure that DoD funds only research projects which are relevant to the DoD mission:

(1) Relevance has always been an established criterion of the legal principles and long-standing RDT&E policies which have governed and will continue to govern the use of Defense appropriations for RDT&E activities. Secretary Packard's memorandum to all DoD components concerning Section 203 of PL 91-121 pointed out that those provisions were, in effect, reiterative of the DoD's policy concerning relevancy, but, to assure full compliance, directed that reviews, documentation, and supplemental directives be accomplished to ensure full compliance with Section 203. This action has been completed for each 6.1 Research and 6.2 Exploratory Development project at the work unit level. About 15,000 tasks were reviewed, of which about 450 (3%) were found to be marginally relevant under a stringent application of the wording in Section 203 which requires a "direct and apparent relationship to a military function or operation."

(2) During the past few years, policies concerning specific areas of research have been modified. It should be noted that prior to the enactment of Section 203 of PL 91-121 actions were taken to de-emphasize, withdraw, and in some cases transfer to other government agencies projects or particular scientific endeavors.

For example, we have de-emphasized the social sciences. We have withdrawn from certain areas of nuclear physics, general mathematics, and some areas of chemistry. We would hope to transfer applicable programs to AEC and NSF.

(3) The DoD Directive 3210.1, subject: "Administration and Support of Basic Research by the DoD" was changed (3 April 1970) to implement a new definition of Defense Research (Attachment #1).

(4) The DoD recognizes the scientific contributions of other agencies like NASA, AEC, HEW, and NSF via special committees, publication exchange, proposal review lists, personal contact, etc. The contributions of the industrial base of the United States are also recognized.

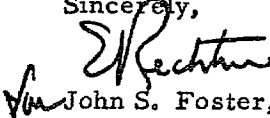
(5) There are many technologies which are "absolutely essential" to insure a strong national defense. Therefore, it is essential that we engage in research to advance and support those technologies. Although research results are sometimes negative, the lack of a desired finding after thorough study may often be very important to a new weapons system concept.

The Department of the Air Force review of the Report is attached. It specifically addresses each of the findings and recommendations, and describes management actions taken as corrective measures where appropriate.

It should be noted that Section 203 of Public Law 91-121, requiring each work unit to have a direct and apparent relationship to a specific military function, was passed more than a year after the beginning of the GAO review, and several years after the initiation of some of the 46 contracts examined during the review. In fact, only 24 of those 46 contracts were still active at the time of the 203 review, and 18 or 75% of that group were found to meet the requirements of Section 203. In light of the fact that 93% of 1,780 OAR work units passed the stringent Section 203 review, the findings of the GAO investigation are not truly representative of the present AFOSR program.

AFOSR's program will continue to evolve as the emphasis on Air Force requirements changes. Their management procedures have been modified in response to your recommendations, and in accordance with the laws and policies under which they must operate.

Sincerely,


John S. Foster, Jr.

Attachments
DoD Directive 3210.1
AF Report

DEPARTMENT OF THE AIR FORCE RESPONSE
TO
GAO DRAFT REPORT TO THE CONGRESS OF THE U. S.

"NEED TO STRENGTHEN MANAGEMENT CONTROL OVER
THE BASIC RESEARCH PROGRAM ADMINISTERED BY THE
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH"

CONTENTS

SECTION I	OVERVIEW
SECTION II	RESPONSE TO RECOMMENDATIONS
SECTION III	COMMENTS ON FINDINGS AND CONCLUSIONS
	A. Introduction
	B. Definitive Criteria for Selecting Research Projects
	C. Surveillance over Research Projects
	D. Obtaining Research Results and Obtaining Them Promptly
	E. Effective Dissemination of Research Results

APPENDIX II

Page 5

Section I - OVERVIEW

The GAO upon their review of various AFOSR contracts, states four basic premises:

- that the management of contract research involves unique problems which make it a difficult area to manage
- that AFOSR interpreted relevance to the Air Force mission very broadly in selecting projects which it funded
- that it lacked the procedures to carry out certain functions effectively
- that established procedures were not consistently followed

AFOSR's program and management have been in constant evolution responding to the changing climate for research supported by the DoD, decreasing budgets, and increasingly stringent requirements for documenting mission application.

Management actions have been taken which meet or surpass many of the recommendations of the GAO report. OAR has implemented changes in their command regulation reflecting the criteria of Section 203. AFOSR has revised their Headquarters Operating Instructions and policies to conform to the GAO report. These are detailed in Section II "Response to Recommendations." It must be noted that the requirement to document this relevance to show a direct and apparent relationship to a specific military function or operation was initiated under Section 203 of Public Law 91-121. Many of the research efforts examined by the GAO were initiated one or more years prior to their review and this could not be expected to reflect current policies and procedures.

[See GAO note, p. 74.]

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Section I - OVERVIEW cont'd

The contracts that were extensively reviewed were preselected by a GAO review team and were not randomly chosen. Eleven of the 46 contracts reviewed were in the Social and Behavioral Sciences, an area that had already been cut drastically by the Air Force. In addition, four more were in the Nuclear Physics area, which has been completely deleted from the Air Force research program. The non-random selection and the constraints of the contract discipline emphasis do not permit credible extrapolation to the total AFOSR program. These and related matters are discussed in detail in Section III "Comments on Findings and Conclusions."

It is also informative to set the GAO sample in context with respect to the requirements of Section 203. Twenty-four of the 46 GAO selected contracts are still active and 18 of these were found to meet the requirements of Section 203. The remaining 22 efforts were not subjected to 203 criteria because they were complete. All 46 contracts were submitted to DDR&E for review and only six were deemed questionable. Of the six, four have been terminated; one will terminate on June 30, 1970, and the last one will terminate on September 30, 1970. By contrast, about 93 percent of all OAR work units (about 1800) passed the stringent requirements of Section 203.

We have found that GAO recommendations were most helpful in reviewing our procedures and in developing better operating methods. The net effect of this review will be to strengthen Air Force research management. To a large extent, actions to effect these improvements have already been accomplished.

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Section II -- RESPONSE TO RECOMMENDATIONS

1. GAO Recommendation

"GAO is recommending that DoD issue definitive criteria to the defense agencies and military services which will adequately limit these agencies to funding projects which are clearly relevant to -- as well as essential to the accomplishment of -- their assigned missions. This criteria should also require that in evaluating need and essentiality consideration be given to the mission of and research performed by other organizations. GAO is also recommending that definitive instructions be issued by DoD which require that the need for each contract and grant be fully disclosed and clearly established in writing and that these justifications be made a part of the official files relating to the contract or grant."

Action

On December 18, 1969, AFOSR issued instructions on evaluation and documentation of that evaluation in the official files. These instructions (Atch 1) specifically include relevance criteria and consideration of the research supported by other agencies. OAR Regulation 500-37, dated February 9, 1970 (Atch 2), provides OAR policy on the criteria to be used in the selection and evaluation of all research efforts conducted or supported by OAR. OAR Regulation 80-1, revised February 2, 1970 (Atch 3) sets forth OAR procedure for evaluating, processing, documenting and reporting the status of proposals for research. Para 4b(1) of that regulation states that OAR Form 43A "Proposal Control and Evaluation," the official OAR form for documenting the technical

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evaluation of an unsolicited proposal and Paragraph 5a requires that the OAR Form 43A become a part of the procurement case file.

2. GAO Recommendation

"That contractors and grantees be required to submit periodic progress reports."

Action

The previous informal methods of obtaining periodic progress reports have been formalized as a contractual (grant) requirement for an annual report to include progress, publications, bibliography, and where appropriate, contemplated major deviations in program and budget (Atch 4).

3. GAO Recommendation

"Guidelines be issued to project scientists (a) establishing a timetable for visiting projects, (b) providing for the data to be obtained on each visit, and (c) requiring adequate documentation of each visit."

Action

1. OAR Regulation 500-38 "Visits to Contractors" was issued on February 9, 1970 (Atch 5). This regulation establishes a minimum of one site visit each year by the scientific monitor or his designated representative. It provides for the information to be obtained on each visit and established the requirement for trip reports being prepared and placed

in the project file.

2. AFOSR interim instruction "Documentation of Significant Events or Changes to a Work Unit" (Atch 6) requires the documentation in the technical project file of trip reports and reports of significance obtained from other sources.

4. GAO Recommendation

"That greater emphasis be placed on procedures for obtaining promptly all reports produced under research projects supported by AFOSR."

Action

Attachment 4, AFOSR Interim Instruction on Progress Reports, requires the submission of annual progress reports with a bibliography of publications produced under the research effort. The requirement in AFOSR HOI 80-3 to review the Final Scientific Report bibliography has been augmented (Atch 7) to include a review of the bibliography in the annual progress reports to insure that appropriate publications have been received.*

*These two actions, along with monitoring for compliance by the AFOSR Assistant Executive Director, Research Operations, will emphasize through line management the requirement to obtain promptly all appropriate publications and will provide the Executive Director with managerial information concerning any deviations.

5. GAO Recommendation

"That project scientists be required to make the results of research projects promptly available to those Air Force organizations having the most interest in such results."

Action

AFOSR has been informally complying continually with this recommendation through many well-established informal mechanisms. OAR Supplement 1 to AFR 80-44 dated December 12, 1969 (Atch 8) formally requires primary distribution lists. This has been further implemented by AFOSR letter "Timely Dissemination of Research Results" with two attachments (Atch 9). The Air Force Form 111 Coupling Program provides a formal mechanism of insuring that appropriate level individuals within AFSC are aware of new discoveries or research results having possible application to on-going technology programs. The AFOSR Technology Alert is to advise key technology users in any organization on a timely basis of development potentials created by AFOSR-supported research investigations in advance of their scientific publication.

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Section III - COMMENTS ON FINDINGS AND CONCLUSIONS

A. Introduction

The preceding section listed management actions taken during the two-year period during which the GAO conducted its review of AFOSR, as well as actions taken subsequent to that review. It should be noted that many of these actions were taken in response to the changing climate for research supported by the DoD. This changing climate is reflected in decreasing budgets and increasingly stringent requirements for documenting relevance.

Relevance has always been a foremost consideration for research proposal selection. It must be noted however that the requirement to document this relevance and further to show its direct and apparent relationship to a specific military function or operation was initiated under Section 203 of PL 91-121. Many of the research efforts examined by the GAO were initiated one or more years prior to the period of the review. Consequently, the files on these efforts could not reflect current policies and procedures. Of course, none of these efforts were initiated under the criteria of Section 203.

B. Definitive Criteria for Selecting Research Projects

While it is true that past AFOSR directives did not require detailed documentation on the work unit basis of the relevance of selected research efforts (work units), relevance to projects has always been a consideration in the selection. In the past, this documentation has been used primarily by AFOSR scientific managers who were themselves competent to translate the individual work unit to the larger project grouping, to the planning guidance and to Air Force needs. The scrutiny now being given individual work efforts by external agencies, and the requirements of Section 203 which introduced the requirement to demonstrate direct and apparent relationship to a function or operation which can be understood by "a reasonable and prudent man," necessitates that our documentation be more complete. Accordingly, directives to this effect have been issued and have been implemented (See Section II).

On page 20, under "National Science Foundation," two efforts are cited as supported by AFOSR after being declined by NSF on the basis of lack of funds. The implication is that if NSF declines to fund a scientifically acceptable effort, which is then picked up by AFOSR, that the effort must perforce be inherently unacceptable from an Air Force relevancy point of view. The Air Force cannot agree that a test for relevancy is whether NSF would or could have supported the same research.

With respect to the 46 cases studied by GAO and the Section 203 review directed by the Deputy Secretary of Defense, of the 24 still active and reviewed, 18 were found to meet the requirements of Section 203 even though they were selected for support under a less stringent definition of relevancy than Section 203. The remaining 22 efforts were not reviewed because they were completed. It is informative to set the GAO sample in context. About 93 percent of all OAR work units (about 1,800) passed the stringent 203 review.

The process of selection of research proposals by AFOSR has been modified by the new requirements of Section 203. None of the 46 research efforts selected by the GAO for review were initially funded under the 203 requirements for clearly demonstrating a direct and apparent relationship to Air Force operations and functions. The full repercussions of 203 upon the AFOSR research program can not yet be assessed, but any discussion today of relevance of research proposals can only be made meaningfully in terms of 203. In response to the far-reaching effects of 203, especially the extensive documentation required to implement the law, selection criteria have been modified, subsequent to the GAO review, by two OAR regulations and one AFOSR Directive (see pp. II-1 to II-3). [See pp. 63 and 64.]

A portion of AFOSR Operating Instruction 80-4 of February 10, 1965 is quoted (p. 12) with the permissive clause regarding the requirement for documenting Air Force and DoD relevance. This instruction was superceded on December 18, 1969, and the permissive clause removed. While relevance to

Air Force mission has always been a required criterion, its documentation was not required to be reflected in the contract file. The GAO Report notes that relevance statements existed for the work units in summaries prepared for annual review purposes.

Pages 13 through 17 list five projects cited as showing remoteness from areas of direct Air Force concern, quoting from the project abstracts. It should be noted that at the time the efforts were selected and initially funded, they were clearly related to the relevance documented at the Project level as well as in the OAR Plan. These in turn were worked out in conjunction with the Air Force using agencies and the OAR Defense Research Sciences Subelement Panels. It is to be noted that the column "Statement of relevancy of project to Air Force Mission as presented by AFOSR" in Appendix I of the GAO report is from the individual work unit documentation and not from the Project or Plan. It was not written as the prime statement of relevancy but was pointed out to the GAO investigators merely as the link from the work unit documentation to the OAR Plan.

Three of these five efforts were allowed to lapse as a result of management decisions ending the foreign area programs, and cutting back the behavioral sciences program. The fourth effort, which will be completed in June 1970, was a one-time effort, not subject to renewal. The fifth effort, while judged to be relevant under 203 criteria, failed to meet the competition for the reduced funding available.

Under "Testimony of Air Force Officials," p. 19, the

report mentions "Study of Cognitive and Effective Attitudes," (conducted by Dr. Henri Tajfel of Oxford University). The statements by the DCS R&D and Assistant Secretary of the Air Force (R&D)¹ cited on pages 19 and 20 refer to the decision by the Air Force to withdraw from foreign area studies and from social science research and not to the relevance of this specific effort.

A discussion of the OAR Five Year Plan (the technical sections of which are available to the public as OAR Research Objectives) begins on page 20 of the GAO report. GAO is of the opinion that each effort should be accompanied by a suitable relevancy statement (p. 23). We concur. The next edition of the Plan will contain a new section on Air Force needs. The Plan will document these needs and interpret the problem statements into research opportunities for meeting those needs. OAR has established an interaction activity of seven task groups to prepare the problem-oriented part of the Plan (see Atch 1, this section).

The GAO report cites (p. 10) the House Committee on Appropriations, Report 1735.

[See GAO note, p. 74.]

The term essentiality is subject to wide interpretation and should be avoided. We believe that all research which we support is both relevant and essential to the successful accomplishment of the Air Force mission in

¹GAO footnote: House Hearings on the Department of Defense appropriations for 1970, pages 436 and 439.

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the future. Thus we apply judgements as to essentiality within the context of relevance, and our documentation of relevancy implicitly addresses essentiality.

C. Surveillance of Research Efforts

On-site visits are desirable, but other well established and successful methods of monitoring research efforts were minimized by the GAO report. The report contends that monitoring was inadequate because four out of the 36 domestic projects had not had on-site visits in the year prior to the review. However, these four investigators had been contacted by their project monitors at least once during that period through visits at AFOSR or by face-to-face discussions held at scientific meetings. In addition, the GAO was concerned that in four out of the 46 cases, written progress reports had not been requested. The project monitor must prepare a progress report on each work unit each year. It had been left to his determination whether or not he needed a written report from the principal investigator or whether his personal contacts with the investigator and the scientific publications received from the effort provided adequate information for this progress report. New procedures now require annual site visits and annual contractor/grantee progress reports. (See Section II)

Further discussion is appropriate concerning two of the four projects singled out by the GAO report.

Cosmic Radiation at Extremely High Energy (page 31)

There was a deviation from the terms of the grant of the type described by the GAO investigators, namely for the budget negotiated. In view of the lack of precedent for an effort involving innovation of equipment on this scale, the departure was necessary to optimize the expenditure of the funds. However, responsible program managers were satisfied that the over-all objectives for which the DOD research money was expended were met.

Theoretical Research in Astrophysics (page 32)

We are unable to account for the statement "...it was difficult to determine what had been done or whether anything had been accomplished..." The facts are that forty-two reports and publications were received under this effort and are on file at AFOSR. Copies were sent to DDC. In addition one book (25 copies received by AFOSR) resulted from this support entitled The Nature of Time edited by Thomas Gold, Cornell University Press, 1967. All reports and publications listed in the final report were submitted in accordance with the requirements of the research agreements.

With regard to the statement in the GAO report "...funds had been used to support graduate students..." it should be noted that Graduate students participated in this effort as research workers. This is a general practice for most research efforts at universities.

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D. OBTAINING RESEARCH RESULTS AND OBTAINING THEM PROMPTLY

While the GAO report does not state specifically which documents were not obtained and placed in AFOSR and DDC files, an internal review of documents associated with the 46 work efforts in the GAO report revealed that less than seven percent of the documents which would appropriately have been included in the AFOSR files and DDC had not been received. Yet, these 46 efforts have produced more than 500 publications which have been included in AFOSR files and DDC.

In many cases, the missing reports concerned were purposely excluded from the files even though they are included in the bibliography of the final report. Examples are theses and brief presentations or papers for specific meetings, the contents of which are contained in other publications. It should also be noted that copies of individual papers included in proceedings are seldom available separately.

E. Effective Dissemination of Research Results

Addressing the specific case discussed by the GAO: Quadratically Nonlinear Differential Systems (page 43). As stated, the final report was a "four page administrative summary", it was not sent to Air Force users or to the Defense Documentation Center precisely because it was an administrative and not a technical document. DDC will not accept and file an "administrative" report.

Two of the referenced manuscripts were incorporated into a single document which was presented at the principal annual meeting of the American Mathematical Society in New Orleans in January, 1969. It has been published in the Journal of Differential Equations, v. 7, n. 2, pp. 251-273, March 1970. As soon as reprints of this article are received by AFOSR, they will be submitted to DDC. The results in the other manuscripts are still being extended and "polished" before formal verbal or written presentation.

GAO note: Deleted comments pertain to material presented in the draft report which has been revised or which has not been included in the final report.

The DOD Directive 3210.1 and the Air Force directives attached to the DOD letter have not been included in this appendix because of their length and because they are not essential to obtaining an understanding of the report and corrective actions being taken.

PRINCIPAL OFFICIALS
OF THE DEPARTMENT OF DEFENSE AND
THE DEPARTMENT OF THE AIR FORCE
RESPONSIBLE FOR ADMINISTRATION OF ACTIVITIES
DISCUSSED IN THIS REPORT

	<u>Tenure of office</u>	
	<u>From</u>	<u>To</u>
<u>DEPARTMENT OF DEFENSE</u>		
SECRETARY OF DEFENSE:		
Melvin R. Laird	Jan. 1969	Present
Clark M. Clifford	Mar. 1968	Jan. 1969
Robert S. McNamara	Jan. 1961	Mar. 1968
DEPUTY SECRETARY OF DEFENSE:		
David M. Packard	Jan. 1969	Present
Paul H. Nitze	July 1967	Jan. 1969
Cyrus R. Vance	Jan. 1964	June 1967
DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING:		
Dr. John S. Foster, Jr.	Oct. 1965	Present
Dr. Harold Brown	May 1961	Sept. 1965
<u>DEPARTMENT OF THE AIR FORCE</u>		
SECRETARY OF THE AIR FORCE:		
Robert C. Seamans, Jr.	Jan. 1969	Present
Harold Brown	Oct. 1965	Jan. 1969
Eugene M. Zuckert	Jan. 1961	Sept. 1965
ASSISTANT SECRETARY OF THE AIR FORCE (RESEARCH AND DEVELOP- MENT):		
Grant L. Hansen	Mar. 1969	Present
Dr. Alexander H. Flax	July 1963	Mar. 1969

PRINCIPAL OFFICIALS
OF THE DEPARTMENT OF DEFENSE AND
THE DEPARTMENT OF THE AIR FORCE
RESPONSIBLE FOR ADMINISTRATION OF ACTIVITIES
DISCUSSED IN THIS REPORT (continued)

<u>Tenure of office</u>	
<u>From</u>	<u>To</u>

DEPARTMENT OF THE AIR FORCE (continued)

COMMANDER, OFFICE OF AEROSPACE
RESEARCH:

Brig. Gen. H. W. Eddy	Aug. 1969	June 1970
Brig. Gen. Leo Kiley	Jan. 1968	July 1969
Brig. Gen. Ernest Pinson	Oct. 1965	Oct. 1967
Maj. Gen. Don Ostrander	Sept. 1962	Oct. 1965
Maj. Gen. Daniel E. Hooks	Apr. 1961	June 1962

EXECUTIVE DIRECTOR, OFFICE OF
SCIENTIFIC RESEARCH:

Dr. William J. Price	Sept. 1963	Present
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